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(54) ELECTROPHORETIC DISPLAY WITH SINGLE CHARACTER ERASURE

ELEKTROPHONETISCHE ANZEIGEVORRICHTUNG MIT ZEICHENLÖSCHUNG

AFFICHAGE ELECTROPHORETIQUE A EFFACEMENT DE CARACTERES INDIVIDUELS

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Description

The present invention relates to electrophoretic displays, and more particularly to a display capable of selective erasure of displayed data.

Electrophoretic displays are now well known. A variety of display types and features are taught in several patents issued in the names of the inventors herein, Frank J. DiSanto and Denis A. Krusos and assigned to the assignee herein, Copytele, Inc. of Huntington Station New York. For example, U.S. Patent Nos. 4,655,897 and 4,732,830, each entitled ELECTROPHORETIC DISPLAY PANELS AND ASSOCIATED METHODS describe the basic operation and construction of an electrophoretic display. U.S. Patent No. 4,742,345, entitled ELECTROPHORETIC DISPLAY PANELS AND METHODS THEREFOR, describes a display having improved alignment and contrast. The inventors herein also have several applications relating to electrophoretic displays presently pending in the Patent Office. Three such applications which may have some relevance to the present invention are Application No. 07/375,056 (published as U.S. Patent No. 5,066,946) entitled ELECTROPHORETIC DISPLAY PANEL WITH SELECTIVE LINE ERASURE, Application No. 07/667,630 (published as U.S. Patent No. 5,223,823) entitled ELECTROPHORETIC DISPLAY PANEL WITH PLURAL ELECTRICALLY INDEPENDENT ANODE ELEMENTS and Application No. 07/345,825 (published as a European Patent Application under No. EP 0396247) entitled DUAL ANODE FLAT PANEL ELECTROPHORETIC DISPLAY APPARATUS, each of which shall be described below to point out their potential relevance.

The display panels shown in the above-mentioned patents operate upon the same basic principle, viz., if a suspension of electrically charged pigment particles in a dielectric fluid is subjected to an applied electrostatic field, the pigment particles will migrate through the fluid in response to the electrostatic field. Given a substantially homogeneous suspension of particles having a pigment color different from that of the dielectric fluid, if the applied electrostatic field is localized it will cause a visually observable localized pigment particle migration. The localized pigment particle migration results either in a localized area of concentration or rarefaction of particles depending upon the sign and direction of the electrostatic field and the charge on the pigment particles. The electrophoretic display apparatus taught in the foregoing U.S. Patents are "triode-type" displays having a plurality of independent, parallel, cathode row conductor members deposited in the horizontal on one surface of a glass viewing screen. A layer of insulating photoresist material deposited over the cathode members and photoetched down to the cathode members to yield a plurality of insulator strips positioned at right angles to the cathode members, forms the substrate for a plurality of independent, parallel column grid conductor members running in the vertical direction. A glass cap member forms a fluid-tight seal with the viewing window along the cap's peripheral edge for containing the fluid suspension and also acts as a substrate for an anode plate deposited on the interior flat surface of the cap. When the cap is in place, the anode surface is in spaced parallel relation to both the cathode members and the grid members. Given a specific particulate suspension, the sign of the electrostatic charge which will attract and repel the pigment particles will be known. The cathode member voltage, the anode voltage, and the grid member voltage can then be ascertained such that when a particular voltage is applied to the cathode and another voltage is applied to the grid, the area proximate their intersection will assume a net charge sufficient to attract or repel pigment particles in suspension in the dielectric fluid. Since numerous cathode and grid lines are employed, there are numerous discrete intersection points which can be controlled by varying the voltage on the cathode and grid members to cause localized visible regions of pigment concentration and rarefaction. Essentially then, the operating voltages on both cathode and grid must be able to assume at least two states corresponding to a logical one and a logical zero. Logical one for the cathode may either correspond to attraction or repulsion of pigment. Typically, the cathode and grid voltages are selected such that only when both are a logical one at a particular intersection point, will a sufficient electrostatic field be present at the intersection relative to the anode to cause the writing of a visual bit of information on the display through migration of a pigment particle. The bit may be erased, e.g., upon a reversal of polarity and a logical zero-zero state occurring at the intersection coordinated with an erase voltage gradient between anode and cathode. In this manner, digitized data can be displayed on the electrophoretic display.

To be useful as a display, an electrophoretic display must be able to assume a blank or erased state; must be able to display character data written during a Write operation; and must be able to continually maintain or hold the written characters (and blank characters) in a Hold mode until they are erased or overwritten. These three modes of operation, i.e., Erase, Write and Hold are well documented in existing patents issued to the inventors herein. Certain aspects of these modes of operation are repeated herein, however, for the convenience of the reader. See U.S. Patent 4,947,157 "APPARATUS AND METHODS FOR PULSING THE ELECTRODES OF AN ELECTROPHORETIC DISPLAY FOR ACHIEVING FASTER DISPLAY OPERATION" issued on August 7, 1990 to Frank DiSanto et al. and assigned to Copytele, Inc.

Given a multi-element cathode and multi-element grid structure as described above, a planar anode, electrically negative, light-colored pigment particles, and a dark-colored, electrically-neutral suspension, the anode face can be completely darkened and the cathode face simultaneously completely lightened by applying a suf-

ficiently large negative voltage on the anode. This condition causes the light-colored, negatively charged particles to migrate from the anode to the cathode. On the way to the cathode, the negative particles will pass through the grid which would be maintained at a voltage permitting passage of the particles therethrough, for example, at zero voltage. Once the anode and cathode screens are rendered monochromic by virtue of the accumulation of negatively-charged, light-colored pigment particles on the cathode elements and the absence of pigment particles on the anode, the respective screens may be deemed "erased".

In any event, if reference is made to the above-noted patents, one will see that such cells or electrophoretic displays essentially contain an anode, a cathode and a grid electrode, which grid electrode further controls the transportation of charged particles. In operation, the charged particles are transferred and forced against one electrode, as the anode or cathode under the influence of an applied electric field, so that the viewer may view the color of the pigment which forms a desired display pattern. In this manner the grid electrode is employed to enable control of the migration of such particles. It is also indicated that when the polarity of the field is reversed, the pigment particles are transported and packed on the opposite electrode. This is indicative, for example, of an erasing mode.

The normal voltages on a typical electrophoretic panel enable the following conditions of operation. The panel can be operated in an Erase Mode where the anode electrode is negative with respect to the cathode electrode which is positive. In this mode the grid electrodes are at a low potential which is equivalent for example to a binary O. In a Hold Mode the anode is positive, the cathodes are positive and the grid electrodes are essentially at zero voltage or at binary 0 level. As one can understand, the cathode operates between zero and positive voltages while the grid operates between low ("0") and high voltages ("1").

As indicated above, a low condition will be indicated by a binary 0 and a high condition is indicated by a binary 1. In any event, during a Write Mode the anode is positive, the cathodes that are being written into are at zero potential and the grids, which are the writing grids, are at a positive or high potential as a binary 1. During this mode all non-writing cathodes are positive and non-writing grids are at low potential or more negative than the cathode.

U.S. Patent No. 5,223,823 relates to another structure for an electrophoretic display in which the previously described grid of electrically independently controllable elements is replaced with a monolithic or electrically continuous grid with pores therein. Further, the monolithic anode is replaced with a plurality of discrete, electrically independent elements. In displays constructed in accordance with the teachings of the aforesaid application, pixel writing and erasure is accomplished by impressing a voltage gradient between a selected anode element and a selected intersecting cathode element such that at their point of intersection, the gradient is sufficient to overcome a constant barrier voltage on the monolithic grid element and cause migration of pigment particles past the grid.

European Application, published under No. 0 396 247 relates to an electrophoretic display having a plurality of independent cathode and grid elements. In addition to a monolithic anode plate (remote anode), a plurality of discrete local anode elements are formed atop and in parallel to either the grid or cathode elements with a corresponding plurality of insulator strips positioned therebetween. This structure is achieved, inter alia, by employing different metals for grid and local anode and performing a two-step etching to form these elements. Selective erasure at the pixel level may be performed by establishing a sufficient voltage gradient at an intersection point of a selected cathode and grid member relative to the remote anode and lowering the potential of the local anode element crossing the particular intersection to ground potential thereby permitting particle passage.

U.S. Patent No. 5,066,946 relates to an electrophoretic display of a type having a plurality of independent cathode and grid elements. The anode is however, divided into a plurality of discrete elements. In Patent No. 5,066,946, a selected line, rather than the entire display screen, can be erased during an erase operation. The independent anode elements are separately addressable and therefore the erase voltage can be impressed upon any selected anode element to erase a line of characters from the display screen. In accordance with the foregoing principles, the typical screen has about 25 horizontal lines for character text; the individual anode elements are approximately 25 in number; and there is one anode element aligned with a corresponding horizontal line of text. All the pixels of an entire line may therefore be erased by impressing the erase voltage upon the corresponding anode element. This feature is beneficial in that the entire screen need not be erased and rewritten when sequential screens differ only slightly. If only the display data which has changed is erased and rewritten, screen rewrite time is saved and display energy requirements are reduced.

A further form of electrophoretic device is described in EP 0 186 519. As for the previous prior art example it comprises a plurality of independent cathode and grid elements and an anode divided into a plurality of discrete elements. Information is written onto the display either repeatedly for set periods of time or for a single selected period of time, in order to implement a grey scale of brightness. Alternatively, the information may be written once for a short period of time, which gives only partial brightness, but may be adequate in some circumstances.

Whereas the above-described applications teach multi-element anodes for use with a monolithic grid; dual anodes, one being monolithic and the other discrete el-

ements parallel to the grid elements for erasure of single pixels, and, in one instance, single line erasure of an electrophoretic display by means of a multi-element ancde. there is no prior teaching concerning a display having a cathode and grid structure like that shown, e.g. in U.S. Patent No. 4,742,345 and having the capacity to selectively erase a single character.

It is therefore an object of the present invention to provide such an electrophoretic display.

The problems and disadvantages associated with the selected erasure of conventional electrophoretic displays are overcome by the present invention which includes an electrophoretic display including a fluid-tight envelope having a portion thereof which is at least partially transparent, an electrophoretic fluid contained within said envelope, said fluid having pigmented particles suspended therein, said electrophoretic display being characterised in that:

means for selectively erasing at least one displayed character with an electrostatic charge without erasing other displayed characters, the erasing means including a first addressable X-Y matrix for selectively establishing a discrete electrostatic charge across at least one intersection of the first X-Y matrix, for erasing said at least one displayed character on said display, the erasing means further including a second addressable X-Y matrix for selectively establishing a discrete electrostatic charge across intersections of the second X-Y matrix for writing pixel data on the display.

For a better understanding of the present invention, reference is made to the following detailed description of an exemplary embodiment considered in conjunction with the accompanying drawings, in which:

FIG. 1 is an exploded perspective view of an electrophoretic display in accordance with an exemplary embodiment of the present invention.

FIG.2 is a cross-sectional view of the electrophoretic display shown in FIG. 1 in the unexploded state, taken along section line II-II and looking in the direction of the arrows.

FIG. 3 is an enlarged perspective view of an anode element of the device depicted in FIGS. 1 and 2.

FIG. 4 is a diagram of a portion of the anode of the display shown in FIGS. 1 and 2 showing an exemplary grouping of anode elements.

FIG. 1 shows an electrophoretic display 10 in accordance with the present invention. The display 10 has an anode faceplate 12 and a cathode faceplate 14 which are sealably affixed on either side of an interstitial wall 16 to form a fluid tight envelope for containing dielectric/pigment particle suspension or electrophoretic fluid (not shown). The faceplates 12 and 14 are typically flat glass plates upon which are deposited conductor elements for controlling the electrostatic charge for inducing motion in the electrophoretic fluid. The techniques, materials and dimensions used to form conductor elements upon the cathode faceplate, i.e., the cathode and grid, are shown in U.S. Patent Nos. 4,655,897, 4,732,830 and 4,742,345

In the present invention, the conductor members on the anode faceplate 12 are configured very similarly to those of the known cathode faceplate 14. In particular, the horizontal anode elements 18 are produced by etching an Indium-Tin-Oxide (ITO) coated glass plate. The present invention differs from previous constructs, however, in that a layer of Silicon Dioxide SiO_2 is then deposited over the etched ITO glass surface. Following deposition of the SiO_2, the conventional construct is continued, i.e., a layer of insulator is then deposited over the SiO_2 layer and the insulator is coated with a metal. The metal is then etched to produce the vertical anode elements 20. Only a few horizontal 18 and vertical 20 anode members are depicted for ease of illustration. Similarly, the shape and proportions of the elements depicted are for purposes of illustration only. In actual displays there are many more elements, e.g., 640 horizontal members and 1280 vertical members. It is common in the art to refer to conductor members like 18 and 20 as "lines". Conductor members oriented in a first direction, such as the horizontal members 18, are frequently described as extending in the "x-direction". The vertical members 20 could then be said to run in the "y-direction", so that when viewed along a line approximately perpendicular to the planes containing the "x" and "y" lines, the x and y lines form a cartesian coordinate system or an x-y matrix. As is known in the art, an x-y matrix of electrically chargeable lines can, via appropriate circuit drivers connected to the lines, be "addressed", such that at any given intersection in the matrix can be impressed with a desired voltage. This construct has been employed in the cathode-grid matrix described in the above referenced patents issued to the inventors herein. The horizontal and vertical members are grouped, however, as shall be described below. U.S. Patent Nos. 4,742,345 and 4,772,820 may be referred to for more verisimilar illustrations of electrophoretic display elements.

Essentially then, the anode faceplate 12 and the elements 18 and 20, with the exception of the SiO_2 layer, have the same basic form as known cathode/grid faceplates. The horizontal anode elements 18 are etched on ITO coated glass as are the conventional horizontal cathode members. The vertical anode elements 20 are superimposed on the horizontal members and are insulated therefrom by an interstitial photoresist layer as the grid members are insulated from the cathode members. The vertical anode elements are formed by coating the photoresist layer with a metal, such as nickel, using sputtering techniques, or the like, and then masked and etched like the conventional grid elements. Thus, the anode is a matrix of a plurality of elongated, parallel, horizontal members 18 upon which is superimposed a plurality of elongated parallel vertical members 20, a strip of insulator electrically and physically separating the two sets of anode elements.

FIG. 2 shows the electrophoretic display of FIG. 1

assembled in a cross-section. The SiO_2 layer 22 deposited over the horizontal anode elements 18 and the supporting anode faceplate 12 surface is visible in this view. Similarly, the remnants of the etched anode insulation layer, i.e., the anode insulator strips 24 can be seen in FIG. 2. An examination of the upper portion of FIG. 2 reveals the cathode elements 26, grid elements 28 and grid insulator strips 30 as are known in the art. All conductor elements are quite thin and extend beneath the interstitial wall 16 at at least one end thereof to provide a terminal exterior to the envelope for connecting display driver circuitry (not shown).

FIG. 3 illustrates the preferred form of the vertical anode elements. As can be seen, the elements are slotted or tined. It is preferred that 640 horizontal elements be deposited upon the anode screen having an overall width of 112 micrometers, a length approximating the viewing screen width and separated one from the next in the vertical direction by a space of 15 micrometers. Groups of 24 horizontal elements are electrically connected at the ends thus giving approximately 26 horizontal anode element groups corresponding to 25 lines of character text to be displayed and erased an additional border area. It is preferred that 1280 vertical anode elements be deposited upon the anode screen (atop the SiO_2 layer 22 and anode insulator strips 24), each having a slotted configuration as shown in FIG. 3 and an overall width of 112 micrometers, a length approximating the viewing screen height and separated one from the next in the horizontal direction by a space of 15 micrometers. Groups of 16 vertical elements (not just the tines) are connected at the ends thus giving 80 vertical anode element groups corresponding to the 80 columns of character text to be displayed and erased. It is preferred that the slots in the vertical anode elements be extended through the insulation layer (strips) 24 as is taught in U.S. Patent No. 4,742,345.

FIG. 4 diagrammatically depicts the grouping of horizontal 18 and vertical 20 anode elements.

In operation, the anode matrix may be used in conjunction with the cathode and grid to selectively erase single characters at the intersection of particular horizontal 18 and vertical 20 anode element groups, or may be operated as a monolithic anode. For example, in single character erase mode, all horizontal (outer) anode elements 18 may be set positive relative to the cathode, grid and vertical (inner) anode elements 20. When a desired character is to be erased, a selected horizontal element 18 group is made negative relative to intersecting vertical anode elements. Thus, at the intersection, and only at the intersection, is the barrier caused by the vertical element 20 group lowered and a sufficient voltage gradient established to induce pigment particle migration. In a similar manner, writing to a selected character location may be enabled or disabled.

Claims

1. An electrophoretic display (10) including a fluid-tight envelope (12,14,16) having a portion thereof which is at least partially transparent, an electrophoretic fluid contained within said envelope (12,14,16), said fluid having pigmented particles suspended therein, said electrophoretic display (10) being characterised in that:

   means for selectively erasing at least one displayed character with an electrostatic charge without erasing other displayed characters, the erasing means including a first addressable X-Y matrix (18,20) for selectively establishing a discrete electrostatic charge across at least one intersection of the first X-Y matrix (18,20), for erasing said at least one displayed character on said display, the erasing means further including a second addressable X-Y matrix (26,28) for selectively establishing a discrete electrostatic charge across intersections of the second X-Y matrix (26,28) for writing pixel data on the display (10).

2. The display (10) of Claim 1, further characterised in that the first addressable X-Y matrix having a first plurality of conductor members in the X-direction (18) and a first plurality of conductor members in the Y-direction (20).

3. The display (10) of Claim 2, further characterised in that the second addressable X-Y matrix having a second plurality of conductor members in the X-direction (26) and a second plurality of conductor members in the Y-direction (28).

4. The display (10) of Claim 3, further characterised in that the first and second matrices are substantially parallel and the intersections thereof occupy fixed positions relative to each other.

5. The display (10) of Claim 4, further characterised in that the intersections of the first matrix (18,20) and the intersections of the second matrix (26,28) exhibit a fixed relative alignment such that each intersection of the second matrix (26,28) is spatially associated with a corresponding intersection of the first matrix (18,20).

6. The display (10) of Claim 5, further characterised in that the X and Y conductor members of the first and second matrices assume voltage levels such that at the respective intersections thereof display data may be written and erased under the control of an electrostatic field established between the corresponding intersections.

7. The display (10) of Claim 6, further characterised in that each of the intersections of the second matrix

(26,28) serves as the loci for a displayable pixel and the intersections of the first matrix (18,20) have an area at least as small as the area of a displayable character composed of displayable pixels.

8. The display (10) of Claim 3, further characterised in that the envelope includes a first flat faceplate (12), a central portion of which is the transparent portion of the envelope, the first faceplate (12) being a substrate for supporting the first plurality of conductor members in the X-direction (18).

9. The display (10) of Claim 8, further characterised in that the envelope includes a second flat faceplate (14) and a wall member (16), the wall member (16) interposed between and sealably attached to the first and second faceplates (12,14) to form the envelope, the second matrix (26,28) being positioned proximate to the second faceplate (14).

10. The display (10) of Claim 9, further characterised in that the first plurality of conductor members in the X-direction (18) are at least partially insulated from the first plurality of conductor members in the Y-direction (20) by an insulator strip (24) underlying each of the first plurality of conductor members in the Y-direction (20) and parallel thereto.

11. The display (10) of Claim 10, further characterised in that the first plurality of conductor members in the X-direction (18) is further insulated from the first plurality of conductor members in the Y-direction (20) by a layer of semiconductor-oxide material (22) deposited over the first plurality of conductor members in the X-direction (18).

12. The display (10) of Claim 11, further characterised in that each of the first plurality of conductor members in the X-direction (18) and each of the first plurality of conductor members in the Y-direction (20) are slotted and the insulator strips (24) underlying the first plurality of conductor members in the Y-direction (20) are slotted.

13. The display (10) of Claim 12, further characterised in that the first plurality of conductor members in the X-direction (18) are grouped into electrically connected groups, each of the groups having a height approximating the height of a displayable character, and the first plurality of conductor members in the Y-direction (20) are grouped into electrically connected groups, each of the groups having a width approximating the width of a displayable character, such that the area of intersection of a group of first conductor members in the X-direction and a group of first conductor members in the Y-direction approximates the area of a single displayable character.

14. The display (10) of Claim 13, further characterised in that the semiconductor-oxide material (22) is Silicon Dioxide.

15. The display (10) of Claim 14, further characterised in that the second faceplate (14) is a substrate for supporting the second plurality of conductor members in the X-direction (26) and wherein the second plurality of conductor members in the X-direction (26) are at least partially insulated from the second plurality of conductor members in the Y-direction (28) by an insulator strip (30) underlying each of the first plurality of conductor members in the Y-direction (28) and parallel thereto, the first and second plurality of conductor members in the X-direction (18,26) being aligned and the first and second plurality of conductor members in the Y-direction (20,28) being aligned.

16. The display (10) of Claim 15, further characterised in that the display (10) is a triode type, the first matrix (18,20) being the anode, the second plurality of conductor members in the X-direction (26) being the cathode and the second plurality of conductor members in the Y-direction (28) being the grid.

17. The display (10) of Claim 16, further characterised in that the second faceplate (14) is at least partially transparent and the electrophoretic fluid is visible therethrough.

18. The display (10) of Claim 14, further characterised in that the second faceplate (14) is a substrate for supporting the second plurality of conductor members in the Y-direction (28) and wherein the second plurality of conductor members in the X-direction (26) are at least partially insulated from the second plurality of conductor members in the Y-direction (28) by an insulator strip (30) underlying each of the first plurality of conductor members in the X-direction (26) and parallel thereto, the first plurality of conductor members in the X-direction (18) being aligned with the second plurality of conductor members in the Y-direction (28) and the first plurality of conductor members in the Y-direction (20) being aligned with the second plurality of conductor Members in the X-direction (28).

19. The display (10) of Claim 18, further characterised in that the display (10) is a triode type, the first matrix (18,20) being the anode, the second plurality of conductor members in the X-direction (26) being the grid and the second plurality of conductor members in the Y-direction (28) being the cathode.

20. The display (10) of Claim 19, further characterised in that the second faceplate (14) is at least partially transparent and the electrophoretic fluid is visible

therethrough.

21. A method for selectively erasing at least one character from an electrophoretic display (10) comprising the steps of:

imposing a set of voltage levels upon the ordinate and abscissa lines of a first addressable X-Y matrix of conductor members (18,20) contained within the display (10) such that across at least one selected intersection of the first X-Y matrix (18,20) an electrostatic field is created which erases a character displayed on the display (10) proximate to the at least one intersection and wherein the display (10) includes a second addressable X-Y matrix (26,28) of conductor members for writing pixel data at the intersections thereof, the intersections of both the first matrix (18,20) and the second matrix (26,28) having a functional relationship such that when the step of erasing is initiated at an intersection of the first matrix (18,20), a predetermined set of pixels of at least one in number are erased at the second matrix (26,28) if previously in a written state.

22. The method of claim 21, wherein the electrostatic field present at the at least one intersection of the first matrix (18,20) during the step of erasing establishes a voltage gradient between the at least one intersection of the first matrix (18,20) and the intersections of the second matrix (26,28) proximate to the predetermined set of pixels, the gradient causing a migration of pigment particles through the electrophoretic fluid of the display (10) away from a display position and into an erase position.

Patentansprüche

1. Elektrophoretisches Display (10) mit einer flüssigkeitsdichten Hülle (12, 14, 16) mit einem Abschnitt, der mindestens teilweise transparent ist, und einem in besagter Hülle (12, 14, 16) enthaltenen elektrophoretischen Fluid, in welchem pigmentierte Partikel schweben, wobei besagtes elektrophoretisches Display (10) dadurch gekennzeichnet ist, daß:

Mittel zum selektiven Löschen von mindestens einem auf dem Display erscheinenden Zeichen mit einer elektrostatischen Ladung ohne Löschen anderer auf dem Display erscheinender Zeichen vorgesehen sind, wobei die Löschmittel aus einer ersten adressierbaren X-Y-Matrix (18, 20) zur selektiven Erzeugung einer separaten elektrostatischen Ladung über mindestens einen Schnittpunkt der ersten X-Y-Matrix (18, 20) zum Löschen des besagten mindestens einen auf dem Display erscheinenden Zeichens sowie aus einer zweiten adressierbaren X-Y-Matrix (26, 28) zur selektiven Erzeugung ein r separaten elektrostatischen Ladung über Schnittpunkte der zweiten X-Y-Matrix (26, 28) zum Schreiben von Bildelementdaten auf dem Display (10) bestehen.

2. Display (10) gemäß Anspruch 1, ferner dadurch gekennzeichnet, daß die erste adressierbare X-Y-Matrix eine erste Vielheit von Leiterelementen in X-Richtung (18) und eine erste Vielheit von Leiterelementen in Y-Richtung (20) aufweist.

3. Display (10) gemäß Anspruch 2, ferner dadurch gekennzeichnet, daß die zweite adressierbare X-Y-Matrix eine zweite Vielheit von Leiterelementen in X-Richtung (26) und eine zweite Vielheit von Leiterelementen in Y-Richtung (28) aufweist.

4. Display (10) gemäß Anspruch 3, ferner dadurch gekennzeichnet, daß die erste und die zweite Matrix im wesentlichen parallel sind und ihre Schnittpunkte im Verhältnis zueinander eine feste Lage einnehmen.

5. Display (10) gemäß Anspruch 4, ferner dadurch gekennzeichnet, daß die Schnittpunkte der ersten Matrix (18, 20) und die Schnittpunkte der zweiten Matrix (26, 28) im Verhältnis zueinander eine feste Ausrichtung aufweisen, so daß ein jeder Schnittpunkt der zweiten Matrix (26, 28) räumlich mit einem entsprechenden Schnittpunkt der ersten Matrix (18, 20) verbunden ist.

6. Display (10) gemäß Anspruch 5, ferner dadurch gekennzeichnet, daß die X- und Y-Leiterelemente der ersten und der zweiten Matrix Spannungswerte annehmen, so daß bei ihren jeweiligen Schnittpunkten unter der Steuerung eines zwischen den entsprechenden Schnittpunkten entstehenden elektrostatischen Feldes Displaydaten geschrieben und gelöscht werden können.

7. Display (10) gemäß Anspruch 6, ferner dadurch gekennzeichnet, daß ein jeder der Schnittpunkte der zweiten Matrix (26, 28) als Ort für ein darstellbares Bildelement fungiert und die Schnittpunkte der ersten Matrix (18, 20) eine Fläche haben, die mindestens so klein ist wie die Fläche eines aus darstellbaren Bildelementen bestehenden darstellbaren Zeichens.

8. Display (10) gemäß Anspruch 3, ferner dadurch gekennzeichnet, daß die Hülle einen ersten flachen Schirmträger (12) aufweist, wovon ein mittlerer Abschnitt den transparenten Teil der Hülle bildet, wobei der erste Schirmträger (12) ein Substrat für die erste Vielheit von Leiterelementen in X-Richtung (18) bildet.

9. Display (10) gemäß Anspruch 8, ferner dadurch gekennzeichnet, daß die Hüll einen zweiten flachen

Schirmträger (14) und ein Wandelement (16) aufweist, wobei das Wandelement (16) zur Bildung der Hülle zwischen den beiden Schirmträgern (12, 14) angeordnet und abdichtbar daran befestigt ist und die zweite Matrix (26, 28) in der Nähe des zweiten Schirmträgers (14) angeordnet ist.

10. Display (10) gemäß Anspruch 9, ferner dadurch gekennzeichnet, daß die erste Vielheit von Leiterelementen in X-Richtung (18) durch einen unter einem jeden der ersten Vielheit von Leiterelementen in Y-Richtung (20) liegenden und parallel dazu verlaufenden Isolationsstreifen (24) zumindestens teilweise gegen die erste Vielheit von Leiterelementen in Y-Richtung (20) isoliert wird.

11. Display (10) gemäß Anspruch 10, ferner dadurch gekennzeichnet, daß die erste Vielheit von Leiterelementen in X-Richttung (18) ferner durch eine über der ersten Vielheit von Leiterelementen in X-Richtung (18) abgelagerte Schicht aus Halbleiter-Oxidmaterial (22) gegen die erste Vielheit von Leiterelementen in Y-Richtung (20) isoliert wird.

12. Display (10) gemäß Anspruch 11, ferner dadurch gekennzeichnet, daß ein jedes der ersten Vielheit von Leiterelementen in X-Richtung (18) und ein jedes der ersten Vielheit von Leiterelementen in Y-Richtung (20) geschlitzt ist und daß die unter der ersten Vielheit von Leiterelementen in Y-Richtung (20) liegenden Isolationsstreifen (24) geschlitzt sind.

13. Display (10) gemäß Anspruch 12, ferner dadurch gekennzeichnet, daß die erste Vielheit von Leiterelementen in X-Richttung (18) in elektrisch miteinander verbundene Gruppen eingeteilt ist, deren Höhe jeweils ungefähr der Höhe eines darstellbaren Zeichens entspricht, und daß die erste Vielheit von Leiterelementen in Y-Richtung (20) in elektrisch miteinander verbundene Gruppen eingeteilt ist, deren Breite jeweils ungefähr der Breite eines darstellbaren Zeichens entspricht, so daß die Fläche des Schnittpunktes einer Gruppe von ersten Leiterelementen in X-Richtung und einer Gruppe von ersten Leiterelementen in Y-Richtung ungefähr der Fläche eines darstellbaren Einzelzeichens entspricht.

14. Display (10) gemäß Anspruch 13, ferner dadurch gekennzeichnet, daß das Halbleiter-Oxidmaterial (22) Siliziumdioxid ist.

15. Display (10) gemäß Anspruch 14, ferner dadurch gekennzeichnet, daß der zweite Schirmträger (14) ein Substrat für die zweite Vielheit von Leiterelementen in X-Richtung (26) bildet, wobei die zweite Vielheit von Leiterelementen in X-Richtung (26) durch einen unter unter einem jeden der ersten Vielheit von Leiterelementen in Y-Richtung (28) liegenden und parallel dazu verlaufenden Isolationsstreifen (30) zumindestens teilweise gegen die zweite Vielheit von Leiterelementen in Y-Richtung (28) isoliert wird, und wobei die erste und zweite Vielheit von Leiterelementen in X-Richtung (18, 26) miteinander fluchten und die erste und zweite Vielheit von Leiterelementen in Y-Richtung (20, 28) miteinander fluchten.

16. Display (10) gemäß Anspruch 15, ferner dadurch gekennzeichnet, daß das Display (10) ein Trioden-Display ist, wobei die erste Matrix (18, 20) die Anode, die zweite Vielheit von Leiterelementen in X-Richtung (26) die Kathode und die zweite Vielheit von Leiterelementen in Y-Richtung (28) das Gitter bildet.

17. Display (10) gemäß Anspruch 16, ferner dadurch gekennzeichnet, daß der zweite Schirmträger (14) mindestens teilweise transparent ist und das elektrophoretische Fluid dadurch zu sehen ist.

18. Display (10) gemäß Anspruch 14, ferner dadurch gekennzeichnet, daß der zweite Schirmträger (14) ein Substrat für die zweite Vielheit von Leiterelementen in Y-Richtung (28) bildet, wobei die zweite Vielheit von Leiterelementen in X-Richtung (26) durch einen unter unter einem jeden der ersten Vielheit von Leiterelementen in X-Richtung (26) liegenden und parallel dazu verlaufenden Isolationsstreifen (30) zumindestens teilweise gegen die zweite Vielheit von Leiterelementen in Y-Richtung (28) isoliert wird, und wobei die erste Vielheit von Leiterelementen in X-Richtung (18) mit der zweiten Vielheit von Leiterelementen in Y-Richtung (28) und die erste Vielheit von Leiterelementen in Y-Richtung (20) mit der zweiten Vielheit von Leiterelementen in X-Richtung (28) fluchtet.

19. Display (10) gemäß Anspruch 18, ferner dadurch gekennzeichnet, daß das Display (10) ein Trioden-Display ist, wobei die erste Matrix (18, 20) die Anode, die zweite Vielheit von Leiterelementen in X-Richtung (26) das Gitter und die zweite Vielheit von Leiterelementen in Y-Richtung (28) die Kathode bildet.

20. Display (10) gemäß Anspruch 19, ferner dadurch gekennzeichnet, daß der zweite Schirmträger (14) mindestens teilweise transparent ist und das elektrophoretische Fluid dadurch zu sehen ist.

21. Verfahren zum selektiven Löschen von mindestens einem Zeichen aus einem elektrophoretischen Display (10), bestehend aus den folgenden Schritten:

Anlegen eines Satzes von Spannungswerten an die Ordinaten- und Abszissenlinien einer ersten

adressierbaren X-Y-Matrix aus Leiterelementen (18, 20) im Display (10), so daß über mindestens einem ausgewählten Schnittpunkt der ersten X-Y-Matrix (18, 20) ein elektrostatisches Feld entsteht, das ein auf dem Display (10) neben dem mindestens einen Schnittpunkt erscheinendes Zeichen löscht, wobei das Display (10) eine zweite adressierbare X-Y-Matrix (26, 28) aus Leiterelementen zum Schreiben von Bildelementdaten an ihren Schnittpunkten aufweist und die Schnittpunkte der ersten Matrix (18, 20) und der zweiten Matrix (26, 28) in einem Funktionsverhältnis zueinander stehen, so daß bei Einleitung des Löschschrittes bei einem Schnittpunkt der ersten Matrix (18, 20) ein vorgegebener Satz von mindestens einem Bildelement, falls zuvor geschrieben, bei der zweiten Matrix (26, 28) gelöscht wird.

22. Verfahren gemäß Anspruch 21, wobei das beim Löschschritt bei dem mindestens einen Schnittpunkt der ersten Matrix (18, 20) vorhandene elektrostatische Feld ein Spannungsgefälle zwischen dem mindestens einen Schnittpunkt der ersten Matrix (18, 20) und den Schnittpunkten der zweiten Matrix (26, 28) neben dem vorgegebenen Satz von Bildelementen erzeugt, wobei das Gefälle eine Wanderung der Pigmentpartikel durch das elektrophoretische Fluid des Displays (10) von einer Displayposition zu einer Löschposition veranlaßt.

Revendications

1. Un afficheur électrophorétique (10) comprenant une enveloppe étanche au fluide (12,14,16) ayant une portion qui est au moins partiellement transparente, un fluide électrophorétique contenu dans ladite enveloppe (12,14,16), ledit fluide ayant des particules de pigment qui y sont suspendues, ledit afficheur électrophorétique (10) étant caractérisé en ce que:

des moyens sont fournis pour effacer sélectivement au moins un caractère affiché avec une charge électrostatique sans effacer les autres caractères affichés, les moyens d'effacement comprenant une première matrice X-Y adressable (18,20) pour établir sélectivement une charge électrostatique discrète sur au moins une intersection de la première matrice X-Y (18,20), pour effacer au moins un caractère affiché sur ledit afficheur, les moyens d'effacement comprenant en outre une seconde matrice X-Y adressable (26,28) pour établir sélectivement une charge électrostatique discrète sur les intersections de la seconde matrice X-Y (26,28) pour écrire les données de pixel sur l'afficheur (10).

2. L'afficheur (10) suivant la Revendication 1, en outre caractérisé en ce que la première matrice X-Y adressable a une première pluralité de membres conducteurs dans la direction X (18) et une première pluralité de membres conducteurs dans la direction Y (20).

3. L'afficheur (10) suivant la Revendication 2, en outre caractérisé en ce que la seconde matrice X-Y adressable a une seconde pluralité de membres conducteurs dans la direction X (26) et une seconde pluralité de membres conducteurs dans la direction Y (28).

4. L'afficheur (10) suivant la Revendication 3, en outre caractérisé en ce que les première et seconde matrices sont substantiellement parallèles et que les intersections de celles-ci occupent des positions fixes les unes par rapport aux autres.

5. L'afficheur (10) suivant la Revendication 4, en outre caractérisé en ce que les intersections de la première matrice (18,20) et les intersections de la seconde matrice (26,28) présentent un alignement relatif fixe de sorte que chaque intersection de la seconde matrice (26,28) est dans l'espace associée à une intersection correspondante de la première matrice (18,20).

6. L'afficheur (10) suivant la Revendication 5, en outre caractérisé en ce que les membres conducteurs X et Y des première et seconde matrices supportent des niveaux de tension tels qu'aux intersections respectives, des données d'affichage peuvent être écrites et effacées sous le contrôle d'un champ électrostatique établi entre les intersections correspondantes.

7. L'afficheur (10) suivant la Revendication 6, en outre caractérisé en ce que chacune des intersections de la seconde matrice (26,28) sert de lieu pour un pixel affichable et les intersections de la première matrice (18,20) ont une surface au moins aussi petite que la surface d'un caractère affichable composé de pixels affichables.

8. L'afficheur (10) suivant la Revendication 3, en outre caractérisé en ce que l'enveloppe comprend une première dalle plate (12), dont une portion centrale est la portion transparente de l'enveloppe, la première dalle (12) étant un substrat pour supporter la première pluralité des membres conducteurs dans la direction X (18).

9. L'afficheur (10) suivant la Revendication 8, en outre caractérisé en ce que l'enveloppe comprend une seconde dalle plate (14) et un membre de paroi (16), le membre de paroi (16) interposé entre et attaché de manière étanche aux première et s conde

dalles (12,14) pour former l'enveloppe. la seconde matrice (26,28) étant placée de manière immédiatement adjacente à la seconde dalle (14).

10. L'afficheur (10) suivant la Revendication 9, en outre caractérisé en ce que la première pluralité de membres conducteurs dans la direction X (18) est au moins partiellement isolée de la première pluralité de membres conducteurs dans la direction Y (20) par une bande d'isolation (24) sous-jacente à chacun des membres de la première pluralité de membres conducteurs dans la direction Y (20) et parallèle à ceux-ci.

11. L'afficheur (10) suivant la Revendication 10, en outre caractérisé en ce que la première pluralité de membres conducteurs dans la direction X (18) est en outre isolée de la première pluralité de membres conducteurs dans la direction Y (20) par une couche d'un matériau d'oxyde semi-conducteur (22) déposé sur la première pluralité de membres conducteurs dans la direction X (18).

12. L'afficheur (10) suivant la Revendication 11, en outre caractérisé en ce que chacun des membres de la première pluralité de membres conducteurs dans la direction X (18) et chacun des membres de la première pluralité de membres conducteurs dans la direction Y (20) sont à fentes et les bandes d'isolation (24) sous-jacentes à la première pluralité de membres conducteurs dans la direction Y (20) sont à fentes.

13. L'afficheur (10) suivant la Revendication 12, en outre caractérisé en ce que la première pluralité des membres conducteurs dans la direction X (18) est groupée en groupes électriquement connectés, chacun des groupes ayant une hauteur faisant approximativement la hauteur d'un caractère affichable, et la première pluralité de membres conducteurs dans la direction Y (20) est groupée en groupes électriquement connectés, chacun des groupes ayant une largeur faisant approximativement la largeur d'un caractère affichable, de sorte que la surface d'intersection d'un groupe de premiers membres conducteurs dans la direction X et d'un groupe de premiers membres conducteurs dans la direction Y correspond approximativement à la surface d'un seul caractère affichable.

14. L'afficheur (10) suivant la Revendication 13, en outre caractérisé en ce que le matériau d'oxyde semi-conducteur (22) est du Dioxyde de Silicium.

15. L'afficheur (10) suivant la Revendication 14, en outre caractérisé en ce que la seconde dalle (14) est un substrat pour supporter la seconde pluralité de membres conducteurs dans la direction X (26) et où la seconde pluralité de membres conducteurs dans la direction X (26) est au moins partiellement isolée de la seconde pluralité de membres conducteurs dans la direction Y (28) par une bande d'isolation (30) sous-jacente à chacun des membres de la première pluralité de membres conducteurs dans la direction Y (28) et parallèle à ceux-ci, les première et seconde pluralités de membres conducteurs dans la direction X (18,26) étant alignées et les première et seconde pluralités de membres conducteurs dans la direction Y (20,28) étant alignées.

16. L'afficheur (10) suivant la Revendication 15, en outre caractérisé en ce que l'afficheur (10) est un type triode, la première matrice (18,20) étant l'anode, la seconde pluralité de membres conducteurs dans la direction X (26) étant la cathode et la seconde pluralité de membres conducteurs dans la direction Y (28) étant la grille.

17. L'afficheur (10) suivant la Revendication 16, en outre caractérisé en ce que la seconde dalle (14) est au moins partiellement transparente et le fluide électrophorétique peut y être vu au travers.

18. L'afficheur (10) suivant la Revendication 14, en outre caractérisé en ce que la seconde dalle (14) est un substrat pour supporter la seconde pluralité de membres conducteurs dans la direction Y (28) et où la seconde pluralité de membres conducteurs dans la direction X (26) est au moins partiellement isolée de la seconde pluralité de membres conducteurs dans la direction Y (28) par une bande d'isolation (30) sous-jacente à chacun des membres de la première pluralité de membres conducteurs dans la direction X (26) et parallèle à ceux-ci, la première pluralité de membres conducteurs dans la direction X (18) étant alignée avec la seconde pluralité de membres conducteurs dans la direction Y (28) et la première pluralité de membres conducteurs dans la direction Y (20) étant alignée avec la seconde pluralité de membres conducteurs dans la direction X (28).

19. L'afficheur (10) suivant la Revendication 18, en outre caractérisé en ce que l'afficheur (10) est un type triode, la première matrice (18,20) étant l'anode, la seconde pluralité de membres conducteurs dans la direction X (26) étant la grille et la seconde pluralité de membres conducteurs dans la direction Y (28) étant la cathode.

20. L'afficheur (10) suivant la Revendication 19, en outre caractérisé en ce que la seconde dalle (14) est au moins partiellement transparente et le fluide électrophorétique peut y être vu au travers.

21. Un procédé pour effacer sélectivement au moins un

caractère d'un afficheur électrophorétique (10) comprenant les étapes de:

application d'un ensemble de niveaux de tension sur les lignes d'ordonnée et d'abscisse d'une première matrice X-Y adressable de membres conducteurs (18,20) contenue dans l'afficheur (10) de sorte qu'en travers au moins une intersection sélectionnée de la première matrice X-Y (18,20) un champ électrostatique est créé qui efface un caractère affiché sur l'afficheur (10) immédiatement adjacent à au moins une intersection où l'afficheur (10) comprend une seconde matrice X-Y adressable (26,28) de membres conducteurs pour écrire des données de pixels aux intersections, les intersections de la première matrice (18,20) et de la seconde matrice (26,28) ayant une relation fonctionnelle de sorte que lorsque l'étape d'effacement est lancée à une intersection de la première matrice (18,20), un ensemble prédéterminé de pixels d'au moins un est effacé au niveau de la seconde matrice (26,28) s'il s'agissait précédemment d'un état écrit.

22. Le procédé suivant la Revendication 21, où le champ électrostatique présent à au moins une intersection de la première matrice (18,20) pendant l'étape d'effacement établit un gradient de tension entre au moins cette intersection de la première matrice (18,20) et les intersections de la seconde matrice (26,28) immédiatement adjacente à l'ensemble prédéterminé de pixels, le gradient entraînant une migration des particules de pigment dans le fluide électrophorétique de l'afficheur (10) d'une position affichage à une position effacement.

FIG-1

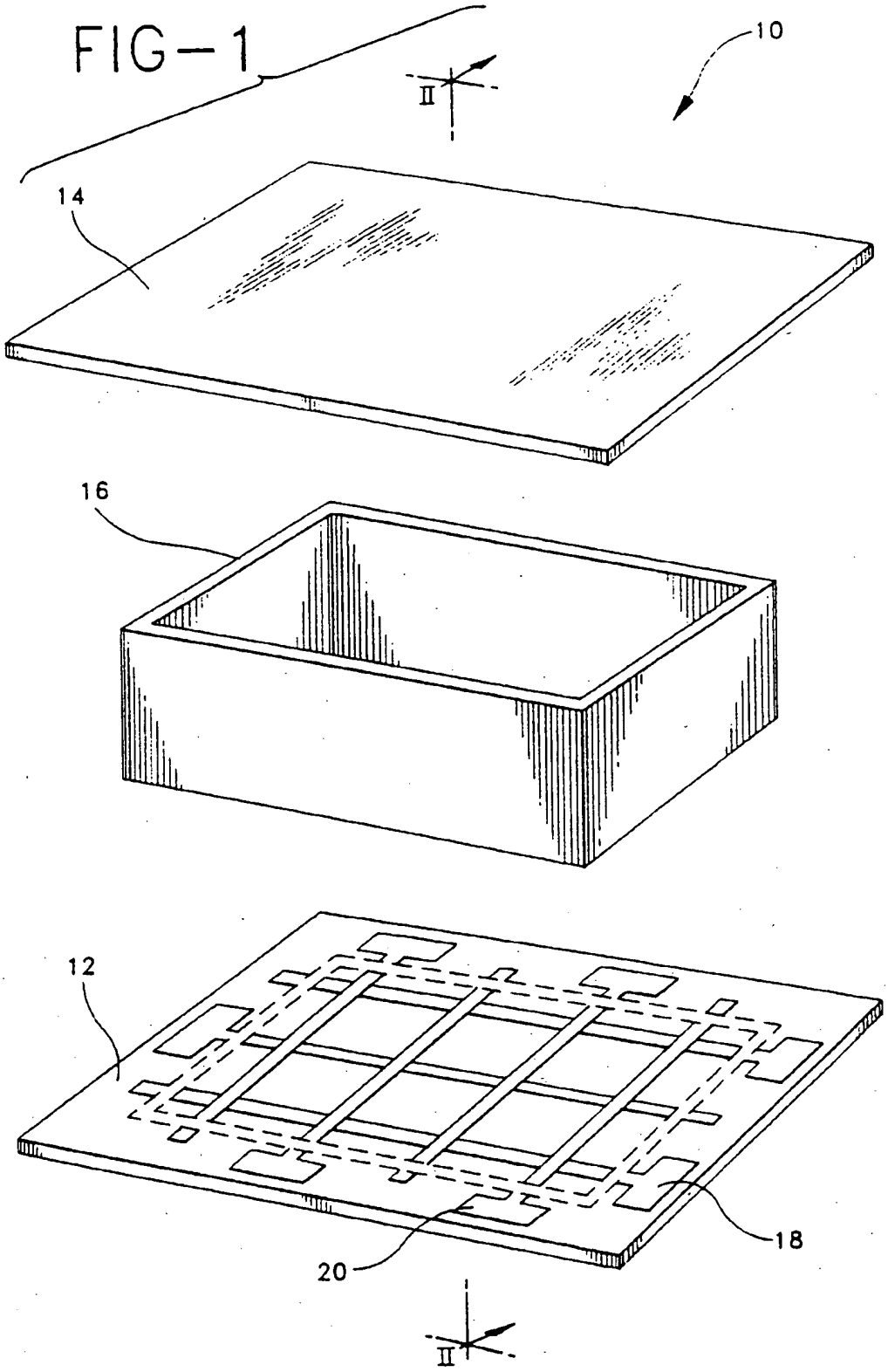

FIG-2

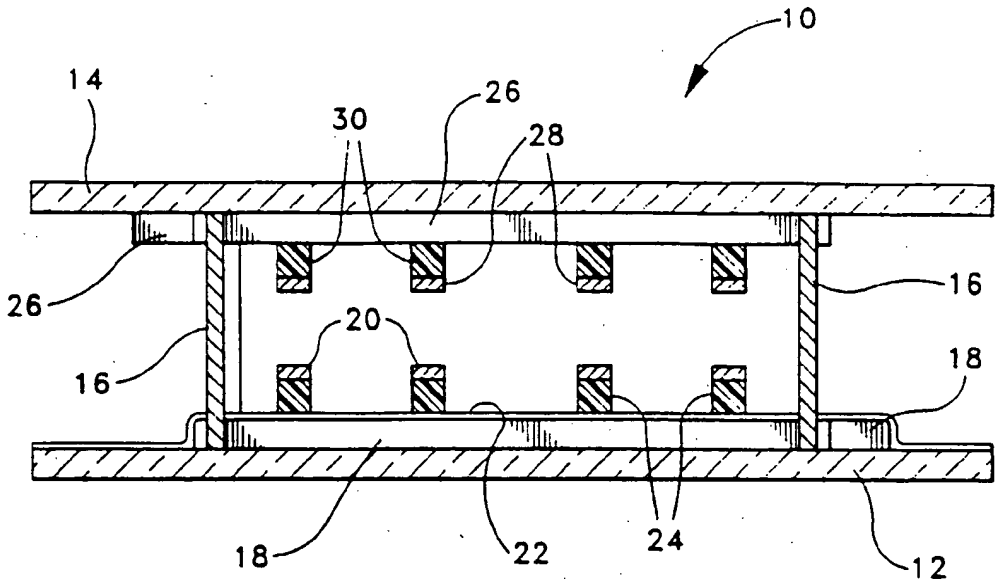

FIG-3

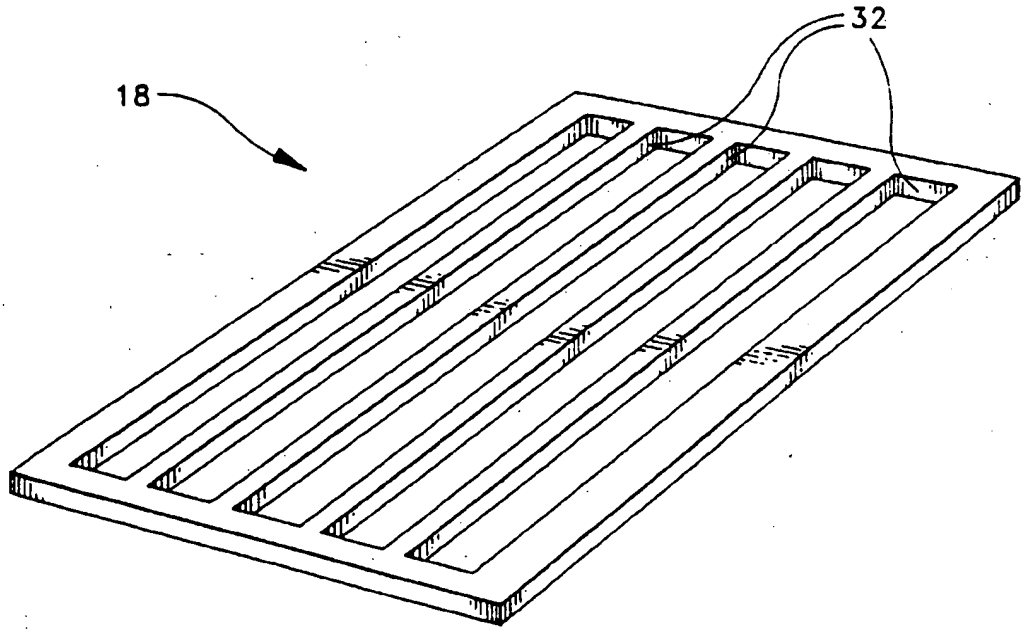

FIG-4